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THE EFFECT OF XYLIDINES ON THE CORROSIVENESS OF AIRCRAFT-ENGINE OIL

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MEMORANDUM REPORT

THE EFFECT OF XYLIDINES ON THE CORROSIVENESS OF AIRCRAFT-ENGINE OIL

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SUMMARY

Tests were performed to determine the effect of xylidines of the corrosiveness of aircraft-engine oil toward engine bearings as part of an investigation on the suitability of xylidines as an antiknock component in aviation gasoline. The Shell thrust-bearing corrosion test was performed with 65 copper-35 lead bearings using new oil both without and with xylidines and used oil from piston-ring sticking engine runs both without and with xylidines added to the fuel and the oil.

The results of the Shell thrust-bearing corrosion test are summarized as follows:

Sample	Bearing loss at 20 hours (mg/cm^2)	
	225° F	320° F
Navy 1120	0.87	16.1
Navy 1120 + 0.5-percent xylidines	1.7	1.0
Navy 1120 + 1-percent xylidines	1.6	3.8
Navy 1120 + 3-percent xylidines	.58	2.2
Navy 1120, used without xylidines	1.4	6.6
Navy 1120, used with xylidines in fuel and oil	.51	4.5

An examination of bearing sections perpendicular to the bearing surface revealed that the corrosion with straight mineral oil was largely a loss of lead and for the corrosion with the oils that contain xylidines the copper in the bearing was attacked as well. The effect of xylidines on the corrosiveness of aircraft-engine lubricating oil was negligible or, if anything, was to render the oil less corrosive toward copper-lead bearings under the conditions of the Shell thrust-bearing corrosion test.

INTRODUCTION

As part of an investigation on the suitability of xylidines as an antiknock component in aviation gasoline, tests were conducted to determine the effect of xylidines on the corrosiveness of aircraft-engine oil toward engine bearings. Such tests were advisable because of the inevitability of fuel contaminating the lubricant either unintentionally from blow-by or intentionally from the practice of "fuel dumping" during cold-weather operation. The Shell thrust-bearing corrosion test was utilized. This test employs a laboratory machine that simulates the more important mechanical factors leading to corrosion of bearings and permits a relative evaluation of oils in regard to bearing corrosion.

New oil with no xylidines and with xylidines added in several concentrations and used oil from piston-ring sticking runs both without and with xylidines added to the fuel and oil were used in the corrosion tests.

The investigation was conducted at the request of the Army Air Forces at the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics, Cleveland, Ohio, during May and June 1943.

APPARATUS AND PROCEDURE

The Shell thrust-bearing corrosion machine has been described in a paper given before the American Chemical Society (reference 1). In the machine three flat bearing specimens, 3/4 by 1/2 inches, are mounted in a steel cup to form a Kingsbury thrust bearing, and corrosion is determined by the weight loss of these bearing specimens after the machine has been operated under prescribed conditions.

Operating Conditions for Thrust-Bearing Corrosion Machine

Temperature, °F	225 and 320
Speed, rpm	2400
Load, lb/sq in.	120
Sample volume, ml	35
Air flow over sample, cm^3/min	5
Steel disk surface	Mirror finish with levigated alumina
Bearing specimen	65 Cu-35 Pb
Bearing specimen surface	Polished (reference 2)
Duration of test, hr	20

In order to provide more complete information on the nature of bearing corrosion, photomicrographs of bearing sections perpendicular to the bearing surface were prepared. These sections were also examined under the light microscope.

TEST SPECIMENS

Bearings. - The 1/2- by 3/4-inch bearing specimens were cut from flat stocks of 65 copper-35 lead. Although it is claimed that the condition of the bearing surface is not critical under the test conditions, both the bearing specimens and the hard steel bearing disk were surfaced by the usual metallographic methods to uniform, reproducible conditions. (See reference 2.)

Oil samples. - New oil samples were prepared from Navy 1120 lubricating oil and xylidines. Properties of the xylidines are listed in reference 3. Used oil samples were obtained at the end of piston-ring sticking tests with a single cylinder from a 12-cylinder liquid-cooled engine. The used oil samples were filtered before testing. The Navy 1120 oil and the xylidines were used in the engine tests.

TABLE OF OILS TESTED

Navy 1120
Navy 1120 + 0.5-percent xylidines
Navy 1120 + 1.0-percent xylidines
Navy 1120 + 3.0-percent xylidines
Series 11, used oil, no xylidines
Series 13, used oil, xylidines in fuel and oil

RESULTS AND DISCUSSION

Figure 1 presents the loss in bearing weight in milligrams per square centimeter for the various oils tested. These are average values for several runs. Average reproducibility was 25 percent. Figure 2 presents representative photomicrographs of bearing sections for each of the oil samples tested.

Reference 1 states that, from the information on oils for which service records are available, corrosion losses

in a 20-hour thrust-bearing corrosion test of less than 0.3 milligrams per square centimeter are negligible, losses from 1 to 5 milligrams per square centimeter indicate that the oil may be potentially corrosive, and losses of 5 milligrams per square centimeter or more indicate the oil to be very definitely corrosive.

At the lower test temperature of 225° F, none of the oils tested displayed more than a very slight potential corrosiveness. The used oil from the piston ring-sticking test with xylidines in the fuel and the oil was not corrosive. At the higher test temperature of 320° F, the Navy 1120 oil both new and used was corrosive under the test conditions; the samples containing xylidines were classified as only potentially corrosive.

An examination of the test-specimen sections revealed that the corrosion with straight mineral oil was largely a loss of lead; whereas, for the corrosion with the oils containing xylidines, the copper in the bearing was attacked as well.

Aircraft Engine Research Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, July 3, 1943.

REFERENCES

1. Talley, S. K., Larsen, R. G., and Webb, W. A.: A Laboratory Machine for Investigating Corrosion of Bearings. Paper presented before Petroleum Div. Am. Chem. Soc. (Atlantic City), Sept. 1941. Abs. in Nat. Petroleum News, vol. XXXIII, no. 38, pp. R-294 and R-296.

2. Grange, H. L.: Metallographic Preparation of Copper-Lead Bearings. Metal Progress, vol. 38, no. 5, Nov. 1940, pp. 674-676.

3. Olson, Walter T.: The Low-Temperature Solubility of Technical Xylidines in Aviation Gasoline. Memo. rep., NACA, June 4, 1943.

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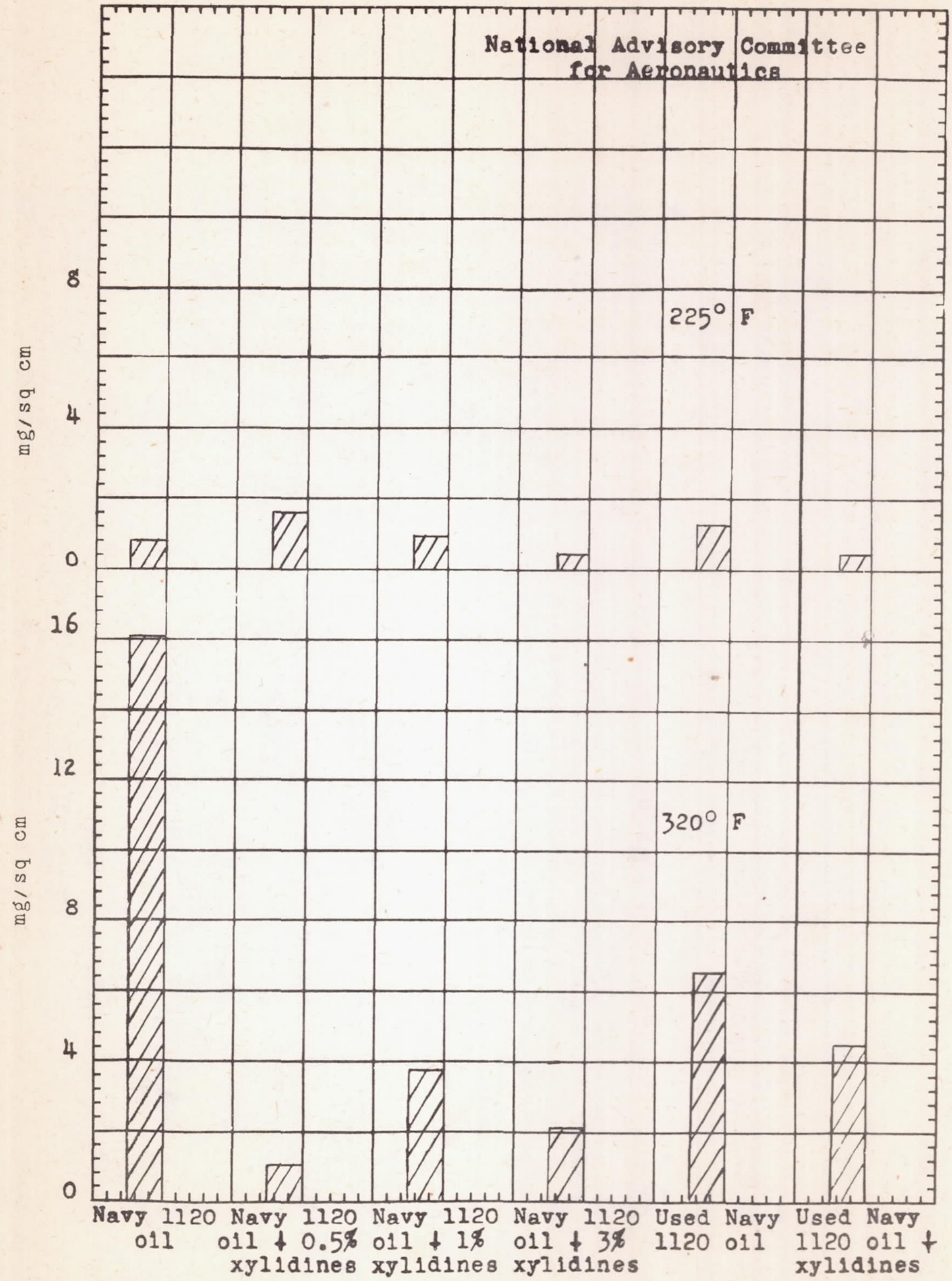

Figure 1. - Effect of xylidines on corrosion. Load, 120 pounds; speed, 2400 rpm; air flow, 5 cubic centimeters per minute; duration of test, 20 hours; specimens, 65 copper-35 lead bearing. (Used oil from ring-sticking tests.)

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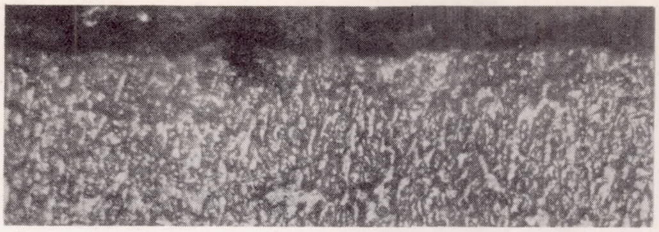
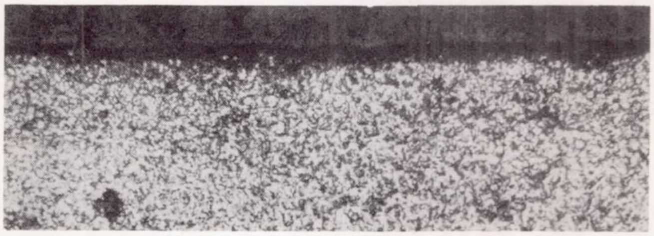
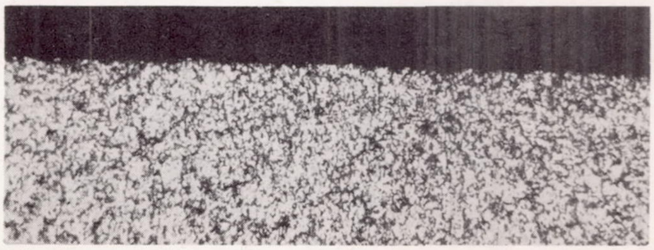


(a) Navy 1120 oil at 225° F. Average loss, 0.87 milligram per square centimeter.

(b) Navy 1120 oil at 320° F. Average loss, 16.2 milligrams per square centimeter.



(c) Navy 1120 oil plus 0.5 percent xylidines at 225° F. Average loss, 1.7 milligrams per square centimeter.



(d) Navy 1120 oil plus 0.5 percent xylidines at 320° F. Average loss, 1 milligram per square centimeter.

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Figure 2. - Corrosion tests on xylidines and Navy 1120 oil Thrust, 120 pounds; speed, 2400 rpm; air flow over surface, 5 cubic centimeters per minute; duration of test, 20 hours; specimens, 65 copper-35 lead bearing. Magnification X400. (Used oil from ring-sticking tests.)

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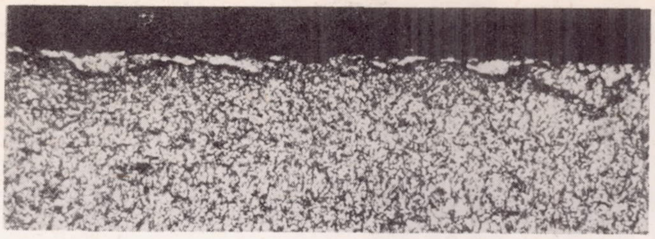
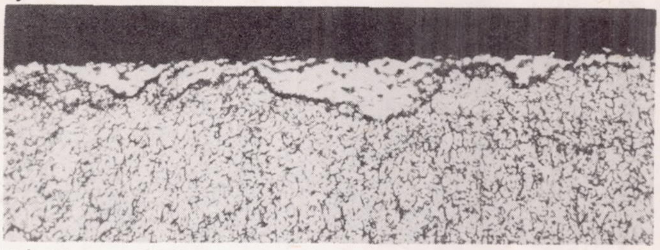
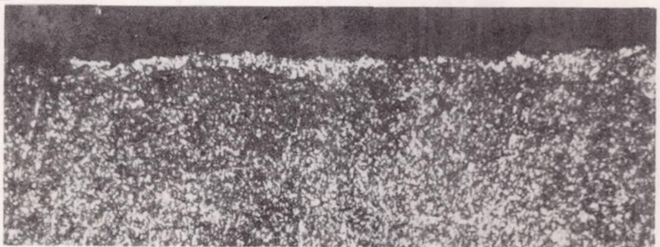


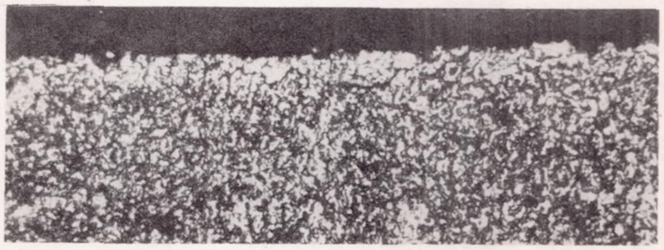
(e) Navy 1120 oil plus 1 percent xylidines at 225° F. Average loss, 1 milligram per square centimeter.



(f) Navy 1120 oil plus 1 percent xylidines at 320° F. Average loss, 3.8 milligrams per square centimeter.



(g) Navy 1120 oil plus 3 percent xylidines at 225° F. Average loss, 0.58 milligram per square centimeter.



(h) Navy 1120 oil plus 3 percent xylidines at 320° F. Average loss, 2.2 milligrams per square centimeter.

Figure 2. - Continued. Corrosion tests on xylidines and Navy 1120 oil. Thrust, 120 pounds; speed, 2400 rpm; air flow over surface, 5 cubic centimeters per minute; duration of test, 20 hours; specimens, 65 copper-35 lead bearing. Magnification X400. (Used oil from ring-sticking tests.)

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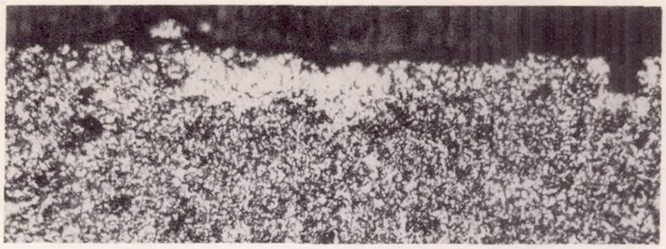
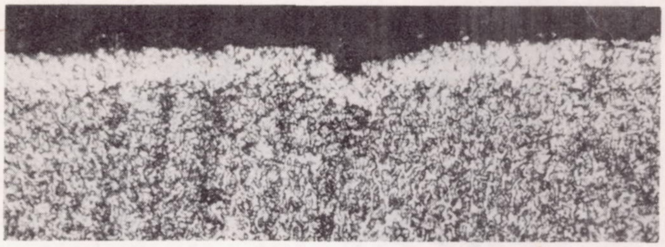
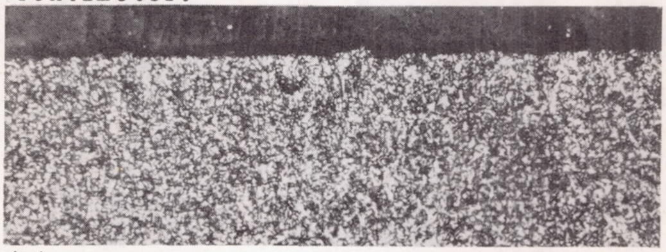


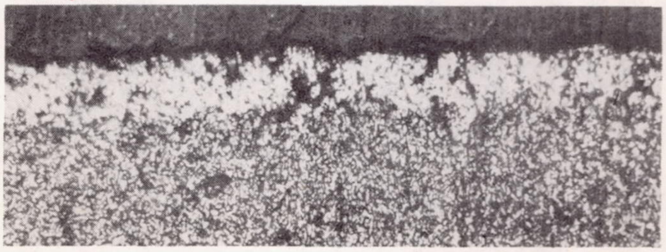
(i) Used Navy 1120 oil from ring-sticking test on single-cylinder engine at 225° F. Average loss, 1.4 milligrams per square centimeter.



(j) Used Navy 1120 oil from ring-sticking test on single-cylinder engine at 320° F. Average loss, 6.6 milligrams per square centimeter.



(k) Used Navy 1120 oil plus 0.5 percent xylidines from ring-sticking test on single-cylinder engine at 225° F. Average loss, 0.51 milligram per square centimeter.



(l) Used Navy 1120 oil plus 0.5 percent xylidines from ring-sticking test on single-cylinder engine at 320° F. Average loss, 4.5 milligrams per square centimeter.

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Figure 2. - Concluded. Corrosion tests on xylidines and Navy 1120 oil. Thrust, 120 pounds; speed, 2400 rpm; air flow over surface, 5 cubic centimeters per minute; duration of test, 20 hours; specimens, 65 copper-35 lead bearing. Magnification X400. (Used oil from ring-sticking tests.)